Assessment of Perfluorinated Compounds in Fish from U.S. Rivers

Leanne Stahl[1], John Wathen[1], Anthony Olsen[2], Blaine Snyder[3], Harry McCarty[4], and Roderick McDowell[5]

Background

EPA's National Rivers and Streams Assessment (NRSA) is one of a series of probability-based surveys designed to assess the condition of U.S. waters. The Office of Water (OW) is responsible for planning and implementing the NRSA with support from the Office of Research and Development (ORD). Under the NRSA framework, the Office of Science and Technology within OW is collaborating with three ORD laboratories to conduct a study of contaminants of emerging concern (CECs) in fish, including perfluorinated compounds (PFCs). Field teams collected fish samples at a statistical subset of 163 urban river sites across the U.S. during 2008 and 2009. Fillet tissue samples from 162 of those sites were analyzed for 13 PFCs.

Why Study PFCs in Fish?

Perfluorinated compounds (PFCs) are a group of synthetic chemicals used to make consumer and industrial products resist oil, grease, stains, and water. Their unique physical and chemical properties prompted their use in non-stick cookware, waterproof clothing, fabric stain protection, and firefighting foams. PFCs are known to accumulate in fish and are of concern because they are persistent, bioaccumulative, and toxic. They have been associated with developmental toxicity, estrogenic effects, thyroid hormone disruption, immune system effects, and cancer in rodent studies.

Study Design

Assessment of PFCs in fish from U.S. urban rivers included:

- Sampling 163 randomly selected urban river sites ($\geq 5^{th}$ order based on 1:100,000-scale Strahler order) in the lower 48 states during 2008 and 2009.
- Collecting one fish composite sample (i.e., 5 similarly sized adult fish of the same species that are consumed by humans) from each site.
- Analyzing fish fillet samples for 13 perfluorinated compounds (PFCs), including perfluorooctanoate (PFOA) and perfluorooctanesulfonate (PFOS).

Author Affiliations

[1]U.S. Environmental Protection Agency
OW/Office of Science and Technology
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460

[2]U.S. Environmental Protection Agency
ORD/National Health and Environmental Effects Research Laboratory
Western Ecology Division
200 SW 35th Street
Corvallis, OR 97333

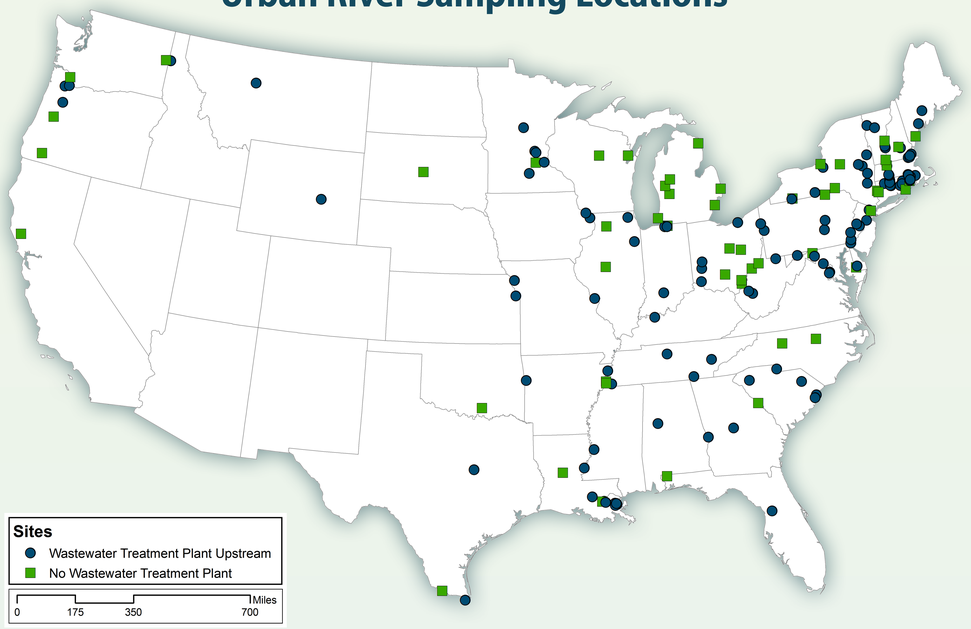
[3]Tetra Tech, Inc.
Center for Ecological Sciences
400 Red Brook Blvd., Suite 200
Owings Mills, MD 21117

[4]CSC
6101 Stevenson Avenue
Alexandria, VA 22304

[5]Jackson State University
Department of Biology
1400 John R. Lynch Street
Jackson, MS 39213

For more information visit: *http://water.epa.gov/scitech/swguidance/fishstudies/*

National Rivers and Streams Assessment Urban River Sampling Locations



Perfluorinated Compounds (PFCs)

Chemical	Use	Chemical	Use
Perfluorobutanesulfonate (PFBS)	New Scotchgard® active ingredient	Perfluorononanoate (PFNA)	Stain-proof coating breakdown product
Perfluorobutanoate (PFBA)	Photographic film production	Perfluorooctane sulfonamide (PFOSA)	Original Scotchgard® breakdown product
Perfluorodecanoate (PFDA)	Stain-proof coating breakdown product	Perfluorooctanesulfonate (PFOS)	Original Scotchgard® active ingredient
Perfluorododecanoate (PFDoA)	Stain-proof coating breakdown product	Perfluorooctanoate (PFOA)	Teflon® and Gore-Tex® emulsifier
Perfluoroheptanoate (PFHpA)	Stain-proof coating breakdown product	Perfluoropentanoate (PFPeA)	Stain-proof coating breakdown product
Perfluorohexanesulfonate (PFHxS)	Fire-fighting foams and carpet treatments	Perfluoroundecanoate (PFUnA)	Stain-proof coating breakdown product
Perfluorohexanoate (PFHxA)	Stain-proof coating breakdown product		

NRSA Fish Tissue Assessments

- First statistically based national assessment of contaminants in fish from U.S. rivers

Collaborators

OW/Office of Science and Technology
- National urban river study management
- SOPs for fish sample collection and preparation
- PFC analysis and data review

OW/Office of Wetlands, Oceans, and Watersheds
- NRSA leadership
- Sample collection management

ORD/National Exposure Research Laboratory (Cincinnati, OH)
- Fish tissue preparation (fillets)

ORD/National Health and Environmental Effects Research Laboratory (Corvallis, OR)
- NRSA study design
- Statistical analysis of PFC data

Target Chemicals

Contaminants of Emerging Concern
- 13 perfluorinated compounds (PFCs)
- 20–30 pharmaceuticals
- 6 musks
- Fillet sample analysis at 163 urban river locations

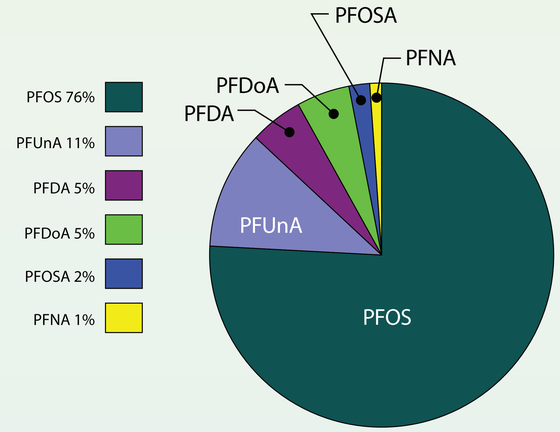
Metals
- Total mercury
- Selenium
- Fillet sample analysis at 565 of the 566 river locations

Organic Compounds
- 21 polychlorinated biphenyls (PCBs)
- 8 polybrominated diphenyl ethers (PBDEs)
- 22 pesticides
- Fillet sample analysis at 566 river locations

PFC Results Summary

- Six of the 13 PFCs were detected in the fillet samples.
- 80% of the samples contained some detectable PFCs, and PFOS was the most frequently detected chemical (found in 73% of all samples).
- The maximum PFOS concentration measured in fillet tissue was 127.5 ppb.
- Based on the results from this study, there was no apparent link between measured concentrations of PFCs and proximity to wastewater treatment plant discharges.

Contributions of Individual PFCs to Total PFC Concentrations in Fish Fillet Samples



PFC Data Summary

Perfluorinated Compound	Abbreviation	MDL[1] (ppb)	Detections (n)	Median[2] (ppb)	Maximum Concentration[2] (ppb
Perfluorobutyric acid	PFBA	2.7	0	*	*
Perfluoropentanoic acid	PFPeA	1.42	0	*	*
Perfluorohexanoic acid	PFHxA	2.34	0	*	*
Perfluoroheptanoic acid	PFHpA	1.25	0	*	*
Perfluorooctanoic acid	PFOA	2.37	0	*	*
Perfluorononanoic acid	PFNA	2.07	1	2.1	2.5
Perfluorodecanoic acid	PFDA	2.63	32	*	28.5
Perfluoroundecanoic acid	PFUnA	2.76	54	*	45.6
Perfluorododecanoic acid	PFDoA	1.38	33	1.4	23.8
Perfluorobutanesulfonic acid	PFBS	5.69	0	*	*
Perfluorohexanesulfonic acid	PFHxS	10.5	0	*	*
Perfluorooctanesulfonic acid	PFOS	5.35	119	10.7	127.5
Perfluorooctanesulfonamide	PFOSA	2.7	7	2.7	63.1
Total Perfluorinated Compounds			**130**		139.1

[1] MDL = method detection limit.
[2] ng/g wet weight or ppb
*<MDL = less than method detection limit.

PFC Assessment Milestones